# Application Trends of Engineered Skin Tissue for Cosmetic Toxicology Detection

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## Introduction

The current status of detection and toxicological evaluation methods for cosmetic ingredients was presented, focuses on the characterization of engineered skin tissue and its application in the detection and toxicology of cosmetic ingredients. The highlight is that a feasibility analysis of skin organoids as an evaluation model in future research is also conducted, with the aim of providing recommendations for the development and application of these innovative *in vitro* models.

Traditional animal models and *in vitro* Two-Dimensional (2D) cellular models are unable to accurately describe the toxic effects of cosmetic ingredients. It also does not adequately consider the influence of the Three-Dimensional (3D) microenvironment under natural physiological conditions on its internal response and affects dose effectiveness and dose toxicity prediction data that cannot provide living tissue structure, mechanical/biochemical signals and cell behavior. Additionally, the discrepancies between species render animal experiments incapable of accurately reflecting human outcomes and imposing significant ethical pressure due to the substantial loss of animal lives. Due to the development of international laboratory animal welfare and the three R's (replacement, reduction and refinement) principles and the progress of science and technology more and more alternative new methods and tools have been applied to the evaluation of cosmetics. Therefore, there is an urgent need for a system that can scientifically and rationally detect cosmetic components and toxicology.

## Description

Engineered skin tissue uses tissue engineering techniques to create skin substitutes to repair injured skin or for other purposes. Artificial skin is constructed by cells and scaffolding materials, which have certain physiological functions and can better restore the ecological environment of skin tissue and the test results more accurately reflect the real quality of cosmetics. The application of an engineered skin tissue technology can provide better statistical test results, which overcomes the problems of immune rejection and difficult access to skin of autologous or allogeneic origin. *In vitro* reconstructed 3D models are used as an alternative means of tissue engineering with material scaffolds, it is highly simulated in terms of gene expression, tissue structure and metabolic activities to realize some operations that cannot be achieved in ordinary 2D cell culture experiments and can also visually present the differential changes of skin structure through stained sections and other methods. Three-dimensional efficacy analysis based on epidermal models can integrate multi-dimensional data at the gene level, protein level and tissue level to achieve comprehensive efficacy evaluation.

Organoid and organ chips are emerging technologies and research hotspots in recent years. As a new type of organoid model, skin organoids can not only highly simulate the physiological structure and function of skin tissue and better restore the real skin ecology in different *in vitro* environment, but also be applied to the fields of skin development research, the research of skin disease pathology and drug screening. The colonization of skin appendages and even the addition of immune cells, causes skin organoids to play an increasingly important role in skin regeneration, tissue repair, drug screening and medical cosmetology. But the structure of human skin is intricate and there remains a significant disparity between most skin organoids and human skin in terms of immune function, material and energy exchange with the external environment. Therefore, the advancement of *in vitro* alternative evaluation methods still has a considerable distance to cover.

## Conclusion

In the current landscape of emerging technologies, novel raw materials, and innovative dosage forms in the cosmetics industry, there is a pressing demand for *in vitro* alternative models that can align with evolving testing and regulatory requirements, enhance efficacy and facilitate comprehensive safety assessment. Under the trend of popular *in vitro* alternative evaluation methods, how to optimize the test conditions and strategies of *in vitro* genotoxicity evaluation, verify the metabolic capacity of engineered skin tissue model and confirm the reliability of the model has become the focus to be solved at this stage.

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